directly they arrive at Atlantic ports; by the aid of which, warnings may be framed, and wired to Europe, of such storms as may appear to threaten its coasts. In this connection it is not possible to overestimate the importance of a telegraph wire to Farö and Iceland, by which warnings of many storms thus seen approaching our coasts, could be issued one or two days earlier at least than at present.

Mr. Clement Ley contributes an extremely interesting, and in some respects a very valuable lecture, on clouds considered as weather-signs, accompanied with nine well-executed illustrations in colours. Mr. Ley has been a close observer of the forms and movements of clouds almost from infancy, being even then strongly under the fascinating spell of their mystery and beauty. Habits of close and accurate observation were thus formed and the tendency has become so inveterate that to this day a twelfth part of his waking existence is spent in observing the clouds. For several years he has given the closest observation and study to a strict examination of the relations of different clouds to cyclones, anticyclones, and to thunderstorms, in other words, to changes of weather. It is the results of this examination which form the most valuable part of the lecture, these results being of the utmost importance to the isolated observer, who may take the trouble to follow up the subject, in enabling him with better success to forecast the weather though aided only by his own observations. A treatment of the subject with greater fulness than is possible in a single lecture would be warmly welcomed by meteorologists and all others interested in weather.

In one of the lectures it is stated with much emphasis that "the great need of every branch of meteorology is neither more observations nor more money (though, neither of these is to be despised), but more brains, more hard workers, more deep thinkers." In a certain sense this is true, but in a wider sense it does not represent the most pressing needs of meteorology. In the last lecture of the series, Mr. Scott justly remarks that as regards synoptic work on a large scale, we may look our critics in the face and boldly ask for more observations, no matter how our shelves may be bending beneath the weight of undiscussed records. The truth is, those who are engaged with original researches in meteorology find themselves ever and anon seriously hampered, if not completely arrested in their work for want of the data of observation. We are unaware that any systems of observation at present exist which could furnish, for example, the data for the determination of the horizontal or vertical meteorological gradients, or for ascertaining how far and with what modifications the influence of the sea extends inland. Nay even, though thanks mainly to the indomitable energy of Mr. Symons, there are upwards of 2,000 gauges recording the rainfall of the British Isles, the number, not to mention positions, of these gauges, are too inadequate to admit of even a rude guess being formed as to the quantity of vapour abstracted from the air in the form of rain or snow during any of the storms that sweep across the country. Much less can we, without largely increased observation, give an indication of the varying hygrometric and thermometric states of the atmospheric currents to windward and leeward of the regions of large rainfall in Great Britain. Meteorologists, no less than astronomers, had cause to deplore a great loss in the death of Leverrier, the keenest sighted of physicists and prince of organisers of systems of observation, one of his last works being the establishment of a system of observation, by which the propagation of rain, hail, and other weather phenomena, could be followed from commune to commune over France. With such results as may be expected from this system, and from General Myer's magnificent scheme of monthly meteorological charts for the whole of the northern hemisphere, which will also bring into the field thousands of fresh observers, physical data leading towards the solution of some of the great meteorological problems will be supplied, without which observational data, mere brain-work—such is the complexity of the problems to be dealt with—would prove either useless or positively mischievous.

OUR BOOK SHELF

Farming for Pleasure and Profit. By Arthur Roland. Edited by W. H. Ablett. (London: Chapman and Hall, 1879.)

THIS small book has the defects as well as the merits which might have been expected in the work of an amateur farmer. His own practice seems usually sound and sometimes ingenious, but his explanations and advice cannot always be safely trusted. When he tells us what he has himself done, we listen with attention; when he offers us page after page full of antiquated veterinary nostrums, we cannot feel edified. We did not know till now that foot-and-mouth disease was *epidemic*; the cause and cure of apthæ (*sic*) is not quite adequately given on p. 205; and we should certainly hesitate before adopting the following treatment (p. 191) for a cow suffering from moor-ill:—"Some insert a seton in the dewlap and take away ten pounds of blood in very severe cases. A recipe has been given to administer, in very obstinate ones, six drachms of aloes, twelve ounces of sulphur, and sixteen drops of croton oil, the first day, in addition to a blood-letting of ten ounces," and so on with further directions of the heroic order. When Mr. Roland tells us of all the breeds of cows, of the cheese-factory system, and of a dozen other matters, of which, so far as we can learn, he has had no actual experience, we feel that his space and our time might have been more profitably occupied. That a good deal of information, and not a little amusement into the bargain, may be got out of Mr. Roland's book, is not to be denied, however. Whether "a great number of persons who would gladly supplement their incomes, if they could see their way clear to do it, by entering into rural occupations which are congenial to their tastes," would be able to follow the lead of Mr. Roland in his farming practice may be gravely doubted. It is not every amateur pig-feeder who will be so lucky as to find "a good pork-butcher, doing a superior trade, and ready to give nearly thirty per cent. more than could be obtained by selling young porkers haphazard." Nor will the amateur pea-grower always be able to adopt the following excellent and economical plan of disposing of his produce. Mr. Roland stows his green peas ready shelled in two flat wicker baskets under the first-class railway carriage in which he daily travels to town. He finds that the landlord of the hotel where he dines in the city will give him one shilling a quart for these peas, fetching them from the cloak-room of the station where they have been deposited. This ingenious method of marketing hardly admits, however, of general adoption; and, moreover, the railway authorities might have something to say about this plan of evading payment of carriage. Mr. Roland's previous attempts to dispose of cabbages and turnips (pp. 16 and 17) were less satisfactory in their

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pecuniary results, though more accordant with ordinary experience. Let the reader of these eight chapters on "Farming for Pleasure and Profit" omit everything except what is given on the personal authority of the author, and he will gain a number of useful hints showing how to economise the vegetable food raised on a small farm, and to make amateur agriculture in some ways less financially disastrous than is usually the case. But we shall not find a complete system of practice here; nor do we discover any hints, however remote, of the chemical composition and physiological functions of food; and we look, too, in vain for any recognition of recent advances in our scientific knowledge as to methods of manuring and cropping.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Theory and Laws of the Microphone

Two hypotheses have been projected to explain the action of the microphone. One is molecular exclusively, and supposes that the molecules of certain conducting bodies contract and dilate under sonorous vibrations. Changes of *density* correspond with an increase or diminution of the resistance of the circuit. This hypothesis renders the phenomena analogous to those which selenium presents under the influence of light and radiant heat. The other explanation, partly mechanical and partly molecular, is the result of a discovery made some time since by M. du Moncel, according to whom the increase or diminution in resistance is due to changes of *pressure* at the points of electric contact. These changes of pressure are effected by the vibration of the air; hence the cause and the effect are similar.

As the result of numerous experiments, I shall endeavour to prove that, while one of these theories is altogether erroneous, the other is only superficially true.

1. If the piece of charcoal is fixed with wax without any pressure, the microphone remains silent under the strongest sonorous impulses, which would be impossible were the movement molecular.

2. The microphone may be inclosed in a vacuous chamber without altering the result; in this case waves of air can have no effect upon the density of the charcoal.

3. It is impossible to construct a microphone from one solid piece of charcoal, presenting stable contact, such as would not interfere with molecular action, but which prevents the sonorous waves from affecting the currents which traverse the carbon.

These afford sufficient reasons for rejecting any simply molecular theory.

Now against the second theory.

1. Lateral pressure on a compact electric conductor excites no microphonic action.

2. Longitudinal pressure within certain limits on the charcoal does not injure the apparatus.

3. An apparatus can be made to yield microphonic effects where there is no alteration of pressure. Pressure, therefore, is no essential cause of microphonic sounds, though it may be an accidental one.

In all microphones where contact is made at one point only, the current is interrupted whenever this point of contact is broken; a musical sound is heard when the two points are in vibration. This microphone, like Reis's telephone, can only transmit musical sounds. I have obtained the best results from a steel point and a membrane of a stretched bladder. A strip of tin-foil is gummed to the membrane to insure electric contact. With a single small cell of bichromate of potash a song can be heard through a whole room.

To transmit articulate sound it is necessary that the number of points of contact, the difference in this number during action, and the resultant changes of resistance, should be greater. The interruption of the current is then only partial; it becomes "undulatory." To this description belong the principal microphone of Mr. Hughes, Edison's carbon telephone, the transmitting telephone of two graphite pencils of MM. Pollard and Garnier, Helleren, &c.

A convenient form of microphone, which transmits words, music, the noise of a watch, &c., has the membrane of india-rubber stretched tight by a thin strip of tin-foil which unites the carbon underneath with the screw. The vibrations of the membrane throw a greater or less number of points into contact; all the shades of expression in the voice may be transmitted, owing to the rapidity of these small changes. It is the changes in the points of contact which here play the chief part, and there is little doubt that here we have the quality as well as the intensity of a sound reproduced.

This explains many of the microphonic actions, but not all. Here is one case:—

If the microphone is formed of two cylindrical pieces of charcoal, the points of contact cannot be made to vary by pressure, supposing the cylindrical shape to be perfect. The action here is due to the distance the current has to traverse the bad conductor; for the membrane to which these charcoal points are attached approaches or recedes from them when vibrating. The liquid telephone transmitters of Bell, Gray, and Salet rest upon the same principle where a change of resistance in the circuit is due to the varying depth of liquid traversed by the current. This, equally with the theory of the points of contact, explains the microphone of M. Righi, where a metallic disk is plunged into a powder of lead and silver mixed.

The next class of instruments consists of those where the current is created, and varies under the influence of microphonic electrodes (by this I mean the opposite parts of a microphone, whether in direct or indirect contact). Such are microphonic batteries. Each battery can act as a microphone if one of its poles is movable. Two ends of iron wire, dipped in ordinary water, and brought together, give signs of microphonic action. One pole is attached to the vibrating membrane, and dips at its extremity into the liquid, while the other pole remains there constantly. The current only passes when the movable pole is in the liquid. On singing into the tube the vibrations of the membrane cause the pole, which is also a microphonic electrode, to dip into the liquid, setting up chemical action as many times a second as there are vibrations in the note sung. If the pole touches the liquid constantly, the current is constant, but varies in intensity for four reasons: the different number of points exposed to electrolytic action; the different number of points of electric contact; the different number of the points of resistance of the liquid; and the different number of the points of approach of one pole to the other; all these are due to the movement of one of the microphonic electrodes.

There is yet another class of microphones. In all the instruments hitherto constructed, the direction of the current remains the same, but it is possible to make it change, thus introducing another difference in the manner of its action.

In all the possible forms of microphone, the chief causes of the action are:—a mechanical movement of its parts, a change in the points of conductivity, a change of resistance; these three essentials result from one another. The expression "points of conductivity" includes not only the points of contact, but also the route taken by the current.

The next point of consideration is the so-called increase of sound by a microphone, but this is not the case. All sounds are weakened by the microphone, and are transmitted only when the source of sound is in direct contact with the microphone or its stand. The microphone is less an instrument for transmitting sound than for transforming mechanical movement into sound. The intensity of a sound is, therefore, directly proportional to the energy of the mechanical movement accompanying the sonorous waves, or as a necessary consequence to the changes of resistance in the microphone. The distinctness of articulate sounds, transmitted by the microphone, is in inverse proportion to their intensity; for a loud sound tends to interrupt completely the current, and thus to prevent the transmission of articulate sounds. This is the chief hindrance to increasing, at pleasure, the loudness of the sound. The loudness of the sound is also dependent on the strength of the current.

Other experiments prove that the rapidity of movement of the parts of a microphone also affects very considerably the resultant sound, as well with a strong, as with a feeble current. Changes in resistance and in current strength are not sufficient, unless made rapidly, to excite microphonic action.

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